

CLCS Prototype Consoles Maintainability Assessment

LCC-X Evaluation

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CLCS Consoles Maintainability Assessment

Introduction

A maintainability assessment was conducted in a joint effort between CCMS Maintenance and CLCS Reliability & Maintainability on the four CLCS console concepts. The purpose of the assessment was as follows:

1. Provide the maintainers of the current system an opportunity to evaluate the various console concepts to offer valuable inputs based on practical experience.
2. Provide Maintainability Engineering personnel with the opportunity to assess the current concepts with respect to the SLS maintainability requirements, and provide a vehicle to supply design input that can be factored into the procurement specifications for the final design concept.

The overall goal of this joint effort was to draw on experience to provide input to the design process to ensure the final product is not only functional but maintainable.

Summary

Both parties involved felt that the exercise was a successful forum for assessing the concepts and providing usable feedback. The input provided in this assessment is strictly from a maintenance/ maintainability standpoint with the goal of the input being factored into the overall assessment.

If a preferred console is to be identified from a maintainability standpoint, one can look at the number of maintenance concerns and issues logged against each individual concept.

From a purely maintainability standpoint, Console C (Venus) and Console D (Mercury) were designed to promote the most efficient, safest means of housing the CLCS equipment in a way that will allow for ease and rapidity with which the system can be restored to operational status following a failure.

Report Setup

For each Console concept the following maintainability information is provided

- Overall impression/comments
- Concerns & Issues Identification Matrix

As a result of this assessment, a **CLCS Console Maintainability Design Guideline Matrix** was developed. This matrix was derived based on the evaluation of current console concepts and lessons learned from previous efforts. The intent of this matrix is that the guidelines outlined herein be utilized in the formation of the final design concept, and the development of procurement specification requirements.

Console A (Mars)

Basic impressions of this concept are that the console takes advantage of some good basic low complexity highly functional design principles. Unfortunately, from a maintainability standpoint, the console has more issues than the other concepts. Many of the issues with this console could be rectified relatively easily, but from an overall standpoint, the console was not designed for maintainability

Console A
Concerns & issues identification matrix

Item (LRU)	Maintainability Issue	Comments/Recommendations
Top monitors	Removal of top monitors - Time consuming maintenance action - Insufficient clearance provided - Monitors can not be removed directly. Maintenance action requires disassembly of monitor swivel base prior to removal of monitor from console.	Removal of Top monitors will have largest impact on system MTTR. This action is a minimum of 2 man effort.
Bottom Monitors	Accessibility for R/R action good - only concern was removal of monitor from back more difficult for maintenance personnel due to monitors weight distribution	Two man maint action
Monitors (all)	Accessing Adjustments on monitors. - console faceplates could use handles to make access to monitor adjustments easier	Bottom monitor adjustments are not readily accessible even after front panel removal.
Keyboard/mouse	Access for R/R action good. Concern with chafe points while pulling wires through access holes.	Recommend addition of grommets to prevent wire chafing/damage during maint action.
Keyboard cover/storage	Difficult and impractical. From a maintenance standpoint the concept is a good idea to provide clear area and protection for keyboard during maint actions. Due to difficulty of use expect system would not be utilized resulting in stacking of keyboards/mice potential for creating additional problems	User friendly storage scheme needs to be developed.
Internal cable routing	Cable routing/pinch points from and around the CPU needs to be addressed	Cables can hang-up and possibly be damaged when CPU drawer slid in and out
PDP	PDP clearance and access good - however the LRU needs to be supported by means other than just front panel. Recommend rail assembly for LRU to rest on and allow unit to slide out after it is unbolted. (similar to Neptune solution). This will turn Maintenance action from 2 man job to 1 man job. Also ensure that final configuration of PDP includes removable incoming power cable as the demo unit has.	Implementation of rails for PDP will do the following for Maintenance time: reduce disassembly time, # of personnel required, and potential for LRU damage. Additionally it will significantly improve reassembly time by allowing LRU to be rest stable at the correct installation height
OIS Com	this LRU also needs some support rails incorporated - this will provide for a safer more efficient maintenance action.	See Neptune support concepts for legacy equipment
Rear doors	Doors must be opened in specific sequence. Could cause inconveniences during maintenance action	Door access (opening & removal) should be independent of each other
Power strips	Provide for more efficient mounting method. Verify that COTS strip is rated to handle power requirements. No spare power receptacles available to support maintenance (test eqpt etc.)	Evaluate using high quality strips, generic power strips tend to have high failure rate.
Filters	Convection cooling utilizing vents with no filters	Evaluate whether or not filters are necessary or whether vent covers should be removable for cleaning.

Console B (Neptune)

This concept had its share of good and bad maintainability features. Rear doors and latches utilized for access were nice and provided the capability to easily remove a door if necessary. However the access panels were secured with non captive hardware which always creates a maintenance concern. The maintenance concerns for this console are more significant in terms of fundamental design changes which would be required to improve the maintainability. Items such as the monitor mounting, heat dissipation and CPU storage/access are significant maintainability issues.

Console B
Concerns & issues identification matrix

Item (LRU)	Maintainability Issue	Comment
Top monitors	No direct access for removal of top monitors. Maintenance action requires the monitor shelf to be lowered prior to removal of monitor.	Lowering of monitor shelf requirement drives the maintenance Action to be a 3 man task. Additionally the potential for damage to equipment or injury to maint. personnel exists during the loosening of hardware securing the loaded shelf.
Bottom monitors	Removal of bottom monitor requires the removal of top monitor first then adjustment of top chassis support rails.	The corrective maintenance time for the bottom monitors will be unnecessarily long - thus contributing to a higher system MTTR
Rear Access Panels	These panels currently do not utilize captive hardware. Recommend such	captive hardware will prevent loss of nuts, bolts during maintenance actions and improve disassembly/reassembly time
Front Access Panels	Bottom front maintenance panels open from the top and rest on the floor in the way of the maintenance personnel.	Access openings should not impede maintenance personnel access
Console Vents	The absence of proper venting contributes to an increased thermal environment	Increased thermal environment will contribute to the reduction of system reliability
Transformer for Barco	Relocate to end or put in powerstrip where spare position will not interfere with wire bend radius	Comment from Mars console regarding sparing and power specs apply also.
PDP	PDP not readily accessible. PDP currently not replaceable without removing another LRU	Relocate PDP
O2 CPU	Difficult to remove for maint action. CPU shelter too low to allow ease of underfloor access	
Center CPU	CPU larger than access opening. CPU will not slide out	Lower shelf after PDP is relocated
Keyboard wells	Area needs enlargement - From support standpoint replacement keyboards may be slightly larger which wells would not accommodate	covers for keyboards are invitation for damage/ loss etc.
Barco/digibus	Due to mounting provisions inadequate airflow between these two LRUs	Inadequate airflow can contribute to reduction of system reliability
Power strips	Provide for more efficient mounting method. Verify that COTS strip is rated to handle power requirements. No spare power receptacles available to support maintenance (test eqpt etc.)	Evaluate using high quality strips, generic power strips tend to have high failure rate.
Filters	Convection cooling utilizing vents with no filters	Evaluate whether or not filters are necessary or whether vent covers should be removable for cleaning.

Console C (Venus)

This concept provided a maintainability friendly environment. With the exception of the monitor mounting and lack of a securing system for top access panels, the console provided good access and simple interface capability. More sophisticated access capability could be added such as sliding shelves for the CPU, however based on the current access, that additional complexity may be unnecessary. It is important to point out that should this concept be modified to provide improved monitor mounting provisions, the design change should not impede current access availability.

Console C
Concerns & issues identification matrix

Item (LRU)	Maintainability Issue (items impacting MTTR)	Comment
Monitors	Custom support for monitors maintainability concern: Need to develop an alternate solution like a shelf etc. Current system requires 2 man operation and modification of COTS equipment (screws into back of monitor)	Develop better support concept for monitor that allows 1 man R/R action and does not require modification of COTS monitor (i.e. rear accessible platform)
removable top panels	removable top panels need securing system	Recommend the use of captive hardware
Filters	Convection cooling utilizing vents with no filters	Evaluate whether or not filters are necessary or whether vent covers should be removable for cleaning.

Console D (Mercury)

From a maintenance standpoint, this console was a Cadillac. Even though the console may not fit the operational profile desired, the workmanship and design for maintainability is superior. However, while this concept promotes accessibility in its design, incorporation of that accessibility in the final product may not necessarily be in the best interest of the program. Most of the items in this console that make the design so maintainable will also add to its complexity.

Console D
Concerns & issues identification matrix

Item (LRU)	Maintainability Issue (items impacting MTTR)	Comment
Cooling Fans	eliminate due to high failure rate item and provide venting	Convection cooling should be utilized
OISD	LRU needs to be supported by means other than just front panel. Recommend rail assembly for LRU to rest on and allow unit to slide out after it is unbolted	Will contribute to a safer more efficient maintenance action.
Filters	Convection cooling utilizing vents with no filters	Evaluate whether or not filters are necessary or whether vent covers should be removable for cleaning.

CLCS Console Maintainability Design Guideline Matrix

Item	Maintainability Design Input
Monitors	All monitors should be mounted in a manner that facilitates handling and prevents damage to units and injury to personnel during R/R. (i.e. mounting, sliding platforms)
Cable/Wire routing	① Measures should be taken to ensure LRU mounting provisions address proper alignment & routing for cables and connectors. ② Cables and wiring that are routed through holes, etc., shall be easily removable and adequately protected with grommets etc
PDP & Legendary equipment	All PDP and legendary equipment should be mounted on support rails to provide chassis weight support while front panel retaining hardware is removed, thus promoting a safer more efficient maintenance action
Access Panels/Doors	①given the fact that most LRU replacements will be large items, removable doors/access panels that do not require special tools to remove are preferred by Maintenance personnel. ② Access openings for maintenance should permit full or partial body access and include space for tools and component passage. ③ Access covers should be equipped with grasp areas or handles to assist in removing and replacing. ④Non-removable access doors shall be self-supporting in the open position. ⑤Handles on consoles shall be recessed to eliminate projections on the surface. If handles cannot be recessed they shall be designed such that they neither injure personnel nor entangle clothing or equipment
Power Strips	Integration of power strips into the console should consider the following three items: ① Account for spares for powering test and maintenance equipment as well as expansion needs. ② Selection of high quality strips ③ Position of strip should support unusual sized plug housings (i.e. Barco Transformer)
Cooling	Console design shall employ convection cooling for thermal control
Cooling - LRU mounting	Mounting of hardware in console should provide adequate spacing between adjacent equipment to provide proper air flow for cooling
LRU removal	Remove/replace items that require removal of other items shall be minimized
Console Lighting	Console lighting shall be designed for ease of R/R of bulbs
Keyboard storage	Keyboard storage concept should strive to eliminate any moving parts or items that will contribute to increased maintenance actions (prefer Venus method)
Mounting Hardware	Mounting provisions should utilize captive hardware to as much extent as possible
Special Tools	Console design should minimize the number of tools/test equipment required for maintenance actions
One Man Operation	Console design should be tailored that the majority of tasks can be accomplished by one technician
Routine Alignments	Routine alignment/adjustment points shall be accessible, preferably on front panel.
Weight Distribution	Weight distribution within rack/consoles shall consider center of mass limitations to prevent hazards during maintenance
Grounding	All external console parts shall be at ground potential at all times
Edges & Corners	All edges and corners shall be rounded or chamfered to prevent injury to personnel or damage to equipment. All burrs and chips produced in machining or construction shall be removed before finish is applied
Materials	Console design shall avoid use of dissimilar material, and if necessary, the use of an interposing material compatible to each dissimilar materiel